BAKER BOTTS L.L.P 10/030333

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TO ALL WHOM IT MAY CONCERN:

Ulrich Lettau, Siegbert Steidl, Wilfried Tautz and Dietrich Wohld, citizens of Germany, residing in Erlangen, Herzogenaurach, Forchheim and Rauschenberg respectively, whose post office addresses are Dummetsweiher 88, 91056 Erlangen, Germany; Schuetzengraben 16D, 91074 Herzogenaurach, Germany; Rotkreuzstr 28 C, 91301 Forchheim, Germany; and Hintere Dorfstr. 3, 91462 Rauschenberg, Germany; respectively, have invented an improvement in:

METHOD AND DEVICE FOR
ROLLING A STRIP OF VARYING THICKNESS

of which the following is a

SUBSTITUTE SPECIFICATION

FIELD OF THE INVENTION

[0001] The invention relates to a method and a device for rolling a metal strip in a rolling train, the rolling train having at least two rolling stands, the metal strip having at least two partial areas of different thicknesses, which are connected to one another via a substantially wedge-shaped transition piece. The rolling velocity of a rolling stand during the rolling of the transition piece is set as a function of the forward slip of the rolling stand, particularly in accordance with the German referene DE-A 197 49 424.

BACKGROUND OF THE INVENTION

[0002] Continuous rolling of a metal strip often leads to changes in thickness of more than 20%, which in turn impose high demands on the setting of the rolling train. On account of the temperature of the strip during hot-rolling, there is very little room for maneuvering between looping and necking. This applies all the more if there are changes in thickness of 50% and more. The German reference DE-A 197 49 424 teaches a method for reducing scrap during the hot-rolling of metal strips. It is an object of the invention to further improve the quality of the rolled product in such a procedure.

SUMMARY OF THE INVENTION

[0003] According to the present invention a method is provided in which a metal strip is rolled in a rolling train having at least two rolling stands, and wherein the metal strip has at least two partial areas of different thicknesses which are connected via a substantially wedge-shaped transition piece. The rolling velocity of the rolling stand during the rolling of the substantially wedge-shaped transition piece is set as a function of the forward slip of the rolling stand and the temperature of the metal strip.

BRIEF DESCRIPTION OF THE INVENTION

[0004] The present invention is described in greater detail below in connection with the drawings, in which:

Figure 1 illustrates a metal strip of variable thickness;

Figure 2 illustrates the curve of set rolling velocities analogous to the method described in DE-A 197 49 424;

Figure 3 illustrates addition values for the set rolling velocity;

Figure 4 illustrates set rolling velocity curves taking account of the forward slip of the rolling stand and the temperature of the metal strip; and

Figure 5 illustrates alternative curves for addition values of the set velocity.

DETAILED DESCRIPTION OF THE INVENTION

[0005] Figure 1 shows a metal strip 1 of variable thickness resulting from a changeover of the pass sequence during rolling. When the metal strip 1 exits the final stand of the rolling train, it has an area 4 having a thickness which corresponds to the thickness in accordance with an old pass sequence, and an area 3 having a thickness which corresponds to the thickness in accordance with the new pass sequence. Area 4 has a greater thickness than area 3. Between the two areas 3 and 4, the metal strip 1 has a wedge-shaped intermediate piece 2. During the changeover of the pass sequence, the reductions and exit thicknesses of all the rolling stands generally change. Therefore, according to DE-A 197 49 424, the rolling stands are changed over from the old pass sequence to the new pass sequence at the appropriate time. Figure 2 shows how the set rolling velocity is adapted in the procedure in accordance with DE-A 197 49 424 for a three-stand rolling train. This figure illustrates the set values for the rolling velocities v plotted against the time t. The rolling velocity of the first stand is denoted v11, v21, the rolling velocity of the second rolling stand is denoted v21, and the rolling velocity of the third rolling stand is denoted v31.

[0006] Figure 3 shows an addition value Δv_L for the set rolling velocity as a function of time t. For the sake of clarity, the scale of the velocity is increased compared to Figure 2 and Figure 4. The addition value Δv_L for the set rolling velocity is set in such a manner that the temperature of the strip corresponds as accurately as possible to a desired set temperature. The set velocities are

changed by the addition value Δv_L compared to Figure 2. Figure 4 shows the result, wherein v12 denotes the set rolling velocity of the first stand, v22 denotes the set rolling velocity of the second stand, and v32 denotes the set rolling velocity of the third stand.

[0007] In addition to the curve of the addition value Δv_L shown in Figure 3 (curve 4), Figure 5 shows further possible curves 5, 6, 7, 8 for the addition value Δv_L. The choice of a suitable curve 4, 5, 6, 7, 8 for the value Δv_L depends on how the desired temperature of the metal strip is to be set. Moreover, it is possible to take account of boundary or auxiliary conditions, for example load limits of the roll drives.

[0008] In a preferred embodiment of the present invention, the calculation of a suitable curve 4, 5, 6, 7, 8 for the addition value Δv_L by adaptation, is calculated by means of a neural network.